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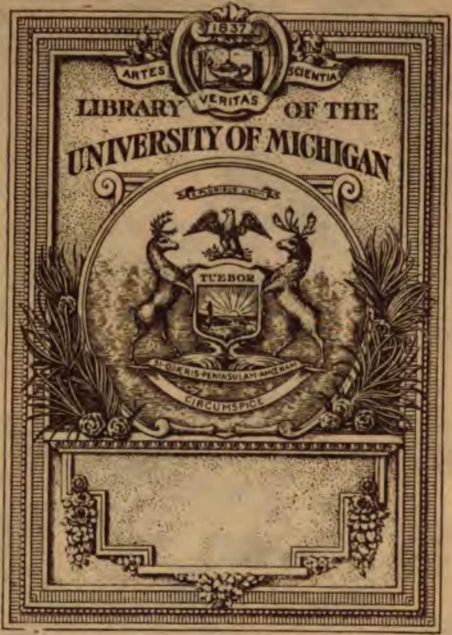
Issued by the
Industrial Accident Commission
of the
State of California

EFFECTIVE JANUARY 1, 1917

CALIFORNIA STATE PRINTING OFFICE
SACRAMENTO
1916



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Electrical Utilization Safety Orders

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INDUSTRIAL ACCIDENT COMMISSION
OF THE STATE OF CALIFORNIA

525 Market Street, San Francisco
423 Union League Building, Los Angeles

A. J. PILLSBURY,
WILL J. FRENCH,
MEYER LISSNER,
Commissioners.

JOHN R. BROWNELL,
Superintendent of Safety.

SUMMARY OF THE SAFETY PROVISIONS
of the
Workmen's Compensation, Insurance and Safety Act.
Chapter 176 of the Laws of 1913.

Sections 51 to 72, inclusive, of the Workmen's Compensation, Insurance and Safety Act give the Industrial Accident Commission power to make and enforce safety orders, rules and regulations, to prescribe safety devices, and to fix safety standards. It also empowers the Commission to appoint advisors who shall, without compensation, assist the Commission in establishing standards of safety. The Commission may adopt and incorporate in its general orders such safety recommendations as it may receive from such advisors.

The Commission, carrying out its plan of obtaining the best practical ideas to incorporate in its Safety Orders, asked various interests to serve on a committee to draft Electrical Utilization Safety Orders.

COMMITTEE ON ELECTRICAL UTILIZATION SAFETY ORDERS:

S. J. Lisberger (chairman), engineer of electrical distribution, Pacific Gas and Electric Company, representing the National Electric Light Association, San Francisco.

J. M. Barry (vice-chairman), chief, Department of Electricity, City of San Francisco.

John Hood, San Francisco engineer, General Electric Company, representing the Manufacturers of Electrical Equipment, San Francisco.

(H. C. Stanley, General Electric Company, alternate to Mr. Hood.)

H. C. Reid, California Association of Electrical Contractors and Dealers, San Francisco.

Carl E. Hardy, superintendent Electrical Department, City of Oakland.

Max A. Schmidt, Schmidt Lithograph Company, representing the California Employers Federation, San Francisco.

F. Emerson Hoar, gas and electrical engineer, State Railroad Commission, San Francisco.

(R. M. Vaughan and P. J. Noerager, State Railroad Commission, alternates to Mr. Hoar.)

George Sorenson, secretary, Local Union No. 537, International Brotherhood of Electrical Workers, San Francisco.

H. M. Hansen, business agent, Local Union No. 404, International Brotherhood of Electrical Workers, San Francisco.

Arthur Elken, Local Union No. 6, International Brotherhood of Electrical Workers, San Francisco.

W. H. Urmy, Local Union No. 6, International Brotherhood of Electrical Workers, San Francisco.

J. Morgenthaler, Pacific District Council, International Brotherhood of Electrical Workers, San Francisco.

R. H. Manahan, city electrician, Los Angeles.

H. Conger Bowers, consulting electrical engineer, Southern California Electrical Contractors and Dealers, Los Angeles.

H. M. Scott, International Brotherhood of Electrical Workers. Los Angeles.

R. L. Eltringham, electrical engineer, Industrial Accident Commission.

John R. Brownell (secretary), superintendent of safety, Industrial Accident Commission.

These Orders are based on the Electrical Utilization section of the Proposed National Electrical Safety Code prepared by the United States Bureau of Standards, which was adopted with certain changes to meet local conditions and for purposes of abridgment.

Acknowledgment is made of the assistance rendered by R. T. Joslin, engineer, Pacific Telephone and Telegraph Company, and A. W. Douglass, division equipment superintendent, Western Union Telegraph Company, who aided in the preparation of the Orders relative to telephone and telegraph equipment.

ELECTRICAL UTILIZATION SAFETY ORDERS.

DEFINITIONS OF SPECIAL TERMS.

Order 700.

(*a*) ELECTRICAL SUPPLY EQUIPMENT means any equipment which produces, modifies, regulates, controls, or safeguards a supply of electrical energy. The supply equipment used in connection with signaling systems is not included under the following conditions:

(1) When the voltage does not exceed 150.

(2) When the voltage does not exceed 400, and the power transmitted does not exceed three kilowatts.

(*b*) ELECTRICAL SUPPLY STATION means any building, room or space within which is located electrical supply equipment.

This includes generating stations and substations, and generator, storage battery and transformer rooms, but excludes isolated transformer vaults on private premises.

(*c*) ELECTRICAL SUPPLY LINES means those conductors and their necessary supporting or containing structures which are located entirely outside of buildings, and used for transmitting a supply of electrical energy.

Telephone and other signal lines are not included (except electric railway signal systems when considered and maintained as supply lines throughout).

(*d*) SIGNAL LINES means lines for public or private signal or communication service, and devoted exclusively to the transmission of signals or intelligence, which operate at not exceeding 400 volts to ground, or 750 volts between any two points of the circuit, and the transmitted power of which does not exceed 150 watts. Below 150 volts no limit is placed on the capacity of the system.

Telephone, telegraph, messenger-call, clock, fire or police alarm, and other systems conforming with the above are included. Lines used for signaling purposes, but not included under the above definition are considered as supply lines of the same voltage and are to be so run. Signal lines not for public use coming under the above definition may be run and operated as supply lines if desired.

(*e*) UTILIZATION EQUIPMENT means those devices and their wiring which utilize electrical energy for mechanical, chemical, heating, lighting, testing or similar purposes, and are a part neither of supply equipment nor of supply lines.

(*f*) VOLTAGE OR VOLTS means the highest effective voltage between the conductors of the circuit concerned, except that in grounded multiwire circuits, not exceeding 750 volts between outer conductors, it means the highest effective voltage between any wire of the circuit and the ground.

1. In ungrounded low voltage circuits, voltage to ground means the voltage of the circuit.
2. When one circuit is directly connected to another circuit of higher voltage (as in the case of an autotransformer), both are considered as of the higher voltage, unless the circuit of lower voltage is permanently grounded. Direct connection

implies electrical connection as opposed to connection merely through electromagnetic or electrostatic induction.

(*g*) CIRCUIT means a conductor or system of conductors through which an electric current is intended to flow.

(*h*) GROUNDED means connected to earth, either intentionally or accidentally.

(*i*) GROUNDED SYSTEM means a system having an effective electrical connection to earth. This ground connection may be at one or more points.

"Effective," as herein used, means a connection to ground of sufficiently low *impedence* and high current-carrying capacity to prevent any current which may be *in* the ground conductor from causing a harmful voltage to exist between the grounded conductors and neighboring exposed conducting surfaces which are in good contact with the earth, or with neighboring surfaces of the earth itself, under the most severe conditions which are liable to arise in practice.

(*j*) PERMANENTLY GROUNDED means such an effective connection to earth (by use of an underground system of metallic pipe mains or other suitable means) as described in section (*i*).

(*k*) CURRENT CARRYING PART means a part intended to be connected in an electric circuit to a source of electric supply.

(*l*) ALIVE OR LIVE means electrically connected to a source having a potential difference, or electrically charged so as to have a potential difference from the earth.

(*m*) DEAD means free from any electrical connection to a source having a potential difference and from electrical charge; not having a potential difference from the earth.

(*n*) MANUAL means operated by personal intervention.

(*o*) AUTOMATIC means self-acting, operating by its own mechanism when actuated by some impersonal influence, as, for example, a change in current strength; not manual; without personal intervention. Remote control that requires personal intervention is not automatic.

(*p*) CUTOUT means any device, such as a fuse or circuit breaker, by which the electrical continuity of a conductor may be automatically broken.

(*q*) SWITCH means a device for opening or closing or changing the connection of a circuit manually, or by means of a suitable mechanism. In these Orders a switch will always be understood to be manually operated, unless otherwise stated.

(*r*) DISCONNECTOR means any switch designed to isolate a piece of apparatus from an electrical source of supply. Disconnectors are not designed to open a circuit under load.

(*s*) SUBSTANTIAL means so constructed and arranged as to be of adequate strength and durability for the service it is to perform under the prevailing conditions.

(*t*) QUALIFIED OR AUTHORIZED means properly qualified or authorized to perform specified duties under the conditions existing.

(*u*) GUARDED means covered, shielded, fenced, inclosed or protected by means of suitable covers or casings, barrier rails or screens, mats or platforms to remove the liability of dangerous contact or approach by persons or objects to a point of danger.

(*v*) ISOLATED means that an object is not readily accessible to persons unless special means for access are used.

(*w*) ISOLATION BY ELEVATION means elevated sufficiently so that persons of ordinary height may safely walk underneath.

(*x*) EXPOSED means that an object or device can be inadvertently touched or approached nearer than a safe distance by any person; objects not suitably guarded.

(*y*) INSULATED means separated from other conducting surfaces by a dielectric substance or air space permanently offering a high resistance to the passage of current, and to disruptive discharge through the substance or space.

When any object is said to be insulated, it is understood to be insulated in suitable manner for the conditions to which it is subjected. Otherwise it is, within the purpose of these Orders, uninsulated. Insulating covering of conductors is one means for making the conductors insulated.

(*z*) INSULATING (where applied to clothing, guards, rods and other safety devices) means that a device, when interposed between a person and current-carrying parts, protects the person making use of it against electric shock from the current-carrying parts with which the device is intended to be used; the opposite of conducting.

(*aa*) EXPLOSION PROOF (in locations where the presence of inflammable gas makes the atmosphere explosive in character) means that type of construction of enclosure which will withstand, without injury, and without transmitting flame to the outside any explosion of gas which may occur in the enclosure.

(*ab*) INCLOSED (in locations where inflammable flyings, inflammable dust or explosives are present in dangerous quantities) means confined within an inclosure which will neither admit accumulations of flyings or dust, nor transmit sparks or flying particles to the accumulations outside.

(*ac*) CONDUCTOR means a metallic conducting material usually in the form of a wire or cable, suitable for carrying an electric current. Does not include bus bars.

(*ad*) LINE CONDUCTOR means one of the conductors carried on and extending along the direction of the pole line.

(*ae*) OPEN LINES means overhead lines consisting of single conductors, or of individual twisted pairs, as opposed to multiple conductor cables.

(*af*) SERVICE means the connecting conductors by which a supply of electrical energy is carried from a supply line to the building or premises served.

(*ag*) LATERAL CONDUCTOR in pole line construction means a conductor extending in a general horizontal direction approximately at right angles to the general direction of the line conductors.

(*ah*) VERTICAL CONDUCTOR in pole line construction means a conductor extending in the general vertical direction of the pole structure.

(*ai*) NORMAL SAG means the difference in elevation between the highest point of support of a span and the lowest point of the conductor in the span (or the curve of the conductor in the span produced) at 60° F., with no wind loading.

(*aj*) APPARENT SAG OF SPAN means the departure of the wire in a given span from the straight line between the two points of support of the span at 60° F., with no wind loading. Where the two supports are at the same level this will be the normal sag.

(*ak*) APPARENT SAG OF A SPAN AT ANY POINT means the departure of the wire at the particular point in the span from the straight line between the two points of support of the span, at 60° F., with no wind loading.

(*al*) POLE FACE means that side of a pole on which cross-arms are attached, or if such cross-arms are on both sides, that semicircumference which is so designated by the utilities owning or operating the pole.

(*am*) CLIMBING SPACE means the vertical space reserved along the side of a pole structure to permit ready access for linemen to equipment and lines located on the pole structure.

(*an*) LATERAL WORKING SPACE means the space reserved for working between conductor levels on either side of a pole, outside the climbing space.

(*ao*) CONFLICTING OR IN CONFLICT (as applied to a pole line) means that the line is so situated with respect to a second line (except at crossings) that the overturning of the first line will result in contact between its poles or conductors and the conductors of the second line. Provided, however, that lines on opposite sides of a highway, street or alley are not considered as conflicting if separated by a distance not less than 60 per cent of the height of the taller pole line, but in no case less than 20 feet.

(*ap*) DUCT means (in underground work) a single tubular runway for underground cables.

(*aq*) CONDUIT means (in underground work) a group of any number of ducts for underground cables.

(*ar*) MANHOLE means an opening in an underground system which workmen or others may enter for the purpose of installing cables, transformers, junction boxes and other devices, and for making connections and tests. Sometimes called a splicing chamber or cable vault.

(*as*) HANDHOLE means an opening in an underground system into which workmen reach but do not enter.

(*at*) TRANSFORMER VAULT means an isolated, fireproof inclosure, either above or below ground, in which transformers, and the devices necessary for their operation, are installed.

(*au*) EXTENSIONS means additions to existing installations.

(*av*) RECONSTRUCTIONS means replacement of any portion of an existing installation by new equipment or construction. Does not include ordinary maintenance replacements.

(*aw*) URBAN DISTRICTS means thickly settled communities (whether in cities or suburbs) where congested traffic often occurs. A highway, even though in the country, on which the traffic is often very heavy, is considered as urban.

(*ax*) RURAL DISTRICTS means all places not urban, usually in the country, but in some cases within city limits.

(*ay*) WIRE GAGES: The American Wire Gage (A.W.G.), otherwise known as Brown & Sharpe (B. & S.), is the standard gage for copper, aluminum and other conductors, excepting steel, for which the Steel Wire Gage (S.W.G.) is used throughout these Orders.

ELECTRICAL UTILIZATION EQUIPMENT.

PROTECTIVE ARRANGEMENTS.

The following Orders apply to electrical utilization equipment over twenty-five (25) volts, as in mills, factories, mercantile establishments, hotels, theaters and other buildings, dwellings, locomotives, cars and other vehicles, and all places coming within the jurisdiction of the Industrial Accident Commission.

Order 701.—**General Requirements.**

(*a*) All electrical utilization equipment shall be of such construction, and so installed and maintained as to reduce the life hazard as far as is reasonably possible.

(*b*) Defective equipment shall be put in good order or permanently disconnected. Defective wiring shall be repaired or removed where hazardous.

(*c*) Installations, repairs, extensions and changes shall be made to existing utilization equipment and conductors only by properly qualified persons.

Order 702.—**Inspections.**

(*a*) Electrical utilization equipment shall comply with these Safety Orders, when placed in service, and shall thereafter be periodically inspected and cleaned when necessary.

Order 703.—**Grounding.**

(*a*) When grounding is required as a permanent and effective protective measure, as specified in these Orders, same shall be done in accordance with the methods specified herein.

(*b*) Ground connections may be made to water piping systems, or direct to the earth through plates, driven pipes, etc.

(*c*) When possible ground wire shall be connected with the water piping system.

1. If the ground wire is connected to the water pipe inside of a building, said connection shall be on the street side of insulating joints or other devices which might interrupt the continuity of the underground pipe metallic systems.
2. When water pipes are not available, a ground rod shall be used, of one (1) inch galvanized pipe driven at least six (6) feet into the ground in a place where moisture is always prevalent (if possible), and adjacent to a pole or some object in order that the said rod may be effectively protected.

The ground connection to all pipes should be made by sweating the ground wire into a lug attached to an Underwriters approved clamp and firmly bolting the clamp to the pipe, thoroughly cleaning the surface of the pipe in order to insure a good metallic connection. If the pipe is thick enough a screw connection may be used instead of a clamp.

3. Copper wire shall be used of a size indicated, as follows:

Capacity of Automatic Cutouts in Amperes.

(Fuses are automatic cutouts.)

	Size of wire
0 to 200	No. 6
201 to 500	No. 4
501 to 1000	No. 2

(*d*) Where the ground wire is exposed to mechanical injury same shall be protected by substantial conduit or other guard, such protection to extend for a distance of not less than eight (8) feet above the ground from the point where the wires are accessible. If the guard is of metal, same shall be permanently and effectively grounded.

(*e*) Ground connections may be made to steel frames of buildings if no metal piping systems are available, provided said method of grounding will secure the necessary conductance.

(*f*) No automatic cutout shall be inserted in any ground connection as covered by these Orders.

(*g*) The neutral in direct and alternating current three-wire distributing systems shall be grounded at the building service by direct connection to a water piping system or to the earth, as above described. The neutral of all transformers supplying three-wire 110/220 volt secondary service shall be grounded at the transformer by direct connection to the earth or to water piping systems or to a ground wire or to the neutral wire of the system, providing said neutral is grounded at a point not farther than 500 feet from the transformer. All secondaries of transformers, or transformer banks shall be grounded, provided the voltage from the ground to any wire does not normally exceed 150 volts.

Where the voltage to ground exceeds 150 volts, grounding is optional. (It is recommended that polyphase secondaries of nominal voltage of 250 volts or less be grounded.)

(*h*) The connection of a lightning arrester to its ground conductor shall be as short and as straight as possible. No ground connections shall be made to any gas piping system, or any other piping system which carries an inflammable substance.

(*i*) Ground wires shall be run separately to the ground (or to a sufficiently heavy grounding bus or system ground which is well connected to ground at more than one place) from equipment and circuits of each of the following classes:

1. Lightning arresters.
2. Secondaries of low voltage lighting or power circuits.
3. Secondaries of current and potential transformers and instrument cases operating on circuits more than 500 volts between wires.
4. The neutrals of 4-wire 3-phase systems.

5. Frames of d.c. railway equipment and equipment operating in excess of 750 volts.

(*j*) Lightning arrester ground connections shall not be made to the same artificial ground (driven pipes or buried plates) as circuits or equipments, but shall be spaced as widely as practicable from other artificial grounds.

(*k*) In addition to the circuits, grounding of which is required by these Orders, all circuits shall be permanently grounded in accordance with these Orders, except that the following need not be grounded:

1. Circuits on two-wire direct current systems.
2. Circuits entirely unexposed to leakage or induction from other circuits either through overhead construction or through transformers or other devices.

It is recommended, however, that all three-wire (not three-phase) circuits, even if unexposed, be grounded at the neutral point, and that multiphase circuits be grounded at the neutral point or middle point of one phase (selecting usually that phase used for lighting).

3. Circuits over 150 volts to ground.
4. Low voltage electric furnace and welding circuits.

(*l*) Under hazardous conditions fixed electrical utilization equipment shall have exposed noncurrent-carrying metal parts, such as frames of motors, of switchboards carrying 750 volts or over, cases of transformers and oil switches, and casings of wiring and conductors, permanently grounded.

EXCEPTION: All equipment erected on poles and not closer than eight (8) feet to the ground shall be exempt from this Order.

(*m*) The following conditions are to be considered hazardous:

1. All voltages over 300 wherever located.
2. All cases where explosives, inflammable gas or inflammable flyings normally exist in dangerous quantities.
3. All cases where exposed grounded surfaces, such as metal frames of other machines, plumbing fixtures, conducting floors or walls exist within the reach of persons when touching metal parts under consideration. Usually grounded surfaces within five (5) feet horizontally of the parts considered and within eight (8) feet vertically of the floor are considered within reach.

EXCEPTIONS: Switchboards—No ground connection need be made to exposed metal frames of switchboards on which all current-carrying parts operate at potentials not exceeding 750 volts to ground; provided that such frames are effectively insulated from the ground and that the switchboards are surrounded to an adequate distance by suitable insulating floors or platforms, and are accessible only to properly qualified and authorized persons.

Parts of machines such as name plates, screws in wood, and similar small parts which are not liable to become alive except under very unusual circumstances are not considered under this Order.

Equipment and fixtures on series circuits, including those in series on railway circuits, need not be grounded under this Order, but should be guarded in so far as practicable from approach.

Order 704.—**Working Space About Electrical Equipment.**

(*a*) Suitable working space shall, where practicable, be provided and maintained about all electrical utilization equipment.

One or more of the following are methods which may be used:

1. By providing barrier guards for all moving parts adjacent to the working space.
2. Where only infrequent attention or adjustment is required, and this only by qualified electrical operators, by having such equipment located at least eight (8) feet above ordinary accessible working space.

Order 705.—**Guarding or Isolating Live Parts.**

(*a*) All ungrounded current-carrying parts of electrical utilization equipment (such as bus bars, conductors and terminals) operating at over 150 volts to ground, and not isolated by elevation at least eight (8) feet above the floor line, shall, where practicable, be provided with suitable permanent inclosures or other guards arranged so as to prevent persons or conducting objects from inadvertently coming (or being brought) in contact with them, but to permit ready access to authorized persons making adjustments or repairs.

Inclosures may consist of suitable casings or suitable insulating coverings. The continuous insulating coverings of conductors should be depended upon only when it is impracticable to install more suitable guards, and then only when very substantial, thoroughly dry and containing no noninsulating flame-proofing compound or oil-soaked rubber. It is recommended that in addition to the protection provided by such coverings the insulating mats or platforms called for in section (*b*) be used.

Where covers, casings or barriers must at any time be removed from the otherwise exposed current-carrying parts which they guard, while these parts are alive, they should be of insulating material, or so arranged that they can not readily be brought in contact with the live parts.

Mats made of wood held together by wood pins are recommended as the best. Cork matting, linoleum, or rubber may be used but are not considered as good as wood mats.

(*b*) Where current-carrying parts at over 150 volts to ground must necessarily be exposed within eight (8) feet from the floor line, all surrounding conducting floors and other noncurrent-carrying surfaces within reach shall be covered with suitable insulating platforms, mats or other insulating devices.

The guarding of live parts will obviate the necessity for such insulating devices, and where the use of the latter is impracticable from the nature of the location or processes carried on, guards should always be used.

(*c*) Trolley or crane collector wires and third rails, except on fenced right of way, or where isolated by elevation, shall be provided with guards so arranged that persons can not inadvertently touch the current-carrying parts while in contact with the ground, or conducting material connected to the ground.

Damp wood or concrete floors are considered conducting, and metal parts of crane cabs are grounded.

(*d*) Bare parts of different potentials shall be effectively separated. Such parts in circuits operating at over 300 volts, shall, where practicable, be provided with suitable barriers, if liable to be short-circuited by tools or other conducting objects.

Order 706.—**Hazardous Locations.**

(*a*) In locations where explosives, inflammable gas or inflammable flyings normally exist in dangerous quantities all parts at which sparking or arcing are liable to occur shall be so inclosed as to prevent hazard.

This protection may be obtained as follows:

1. By placing in separate compartments or rooms.
2. By using casings of the inclosed type when dust or flyings are present.
3. By using explosion-proof casings when inflammable gases exist in dangerous quantities.

(*b*) All casings shall be nonabsorptive, noncombustible and when of metal shall be permanently grounded if within reach of grounded surfaces.

Order 707.—**Identification.**

(*a*) Where necessary for safety, electrical utilization equipment shall be suitably identified with voltage and intended use.

STORAGE BATTERIES.

The following Orders apply to storage batteries exceeding fifteen (15) kilowatt-hour capacity at the eight-hour rate of discharge.

Order 708.—**Isolation.**

(*a*) Storage batteries exceeding 150 volts to ground shall be made inaccessible to other than properly qualified persons, by being placed in a separate room or inclosure.

(*b*) Where nonportable storage batteries are placed in rooms occupied also by other equipment, adequate guards or inclosures shall be provided when necessary to prevent the approach of unauthorized persons.

Order 709.—**Ventilation.**

(*a*) Rooms or inclosures containing storage batteries shall be so ventilated as to remove acid spray and prevent dangerous accumulation of inflammable gas.

Communication of drafts to other rooms should be prevented.

Order 710.—**Suitable Supports and Floors.**

(*a*) The cells shall be supported by suitable insulators.

(*b*) Suitable drainage or other means shall be provided beneath cells to prevent the accumulation of electrolyte in case of leakage or spraying.

Acid-resistive floors, such as vitrified brick set in pitch, are recommended where large batteries are installed.

Order 711.—**Guarding Live Parts in Battery Rooms.**

(*a*) The arrangement of cells shall be such that no two-current carrying parts between which a voltage exceeding 150 exists shall be closer than three (3) feet, if the parts are so exposed that persons may make accidental contact with both at the same time.

Order 712.—**Illumination.**

(*a*) Storage battery rooms shall, if practicable, be lighted from lamps outside of battery room. If lamps are located inside, only incandescent units in keyless porcelain or composition sockets, all inclosed in moisture-proof globe, shall be used. Control switches to these lights must not be exposed to battery vapor.

Order 713.—**Acid-Resistive Coverings.**

(*a*) Conductors about batteries, if of such material or so located as to be liable to corrosion, shall have suitable protective coverings or coatings.

TRANSFORMERS.

Order 714.—**Current Transformer Secondary Circuits.**

(*a*) Current transformer secondary circuits, including those supplied from constant current and instrument transformers (except those supplying relays only, or those having their primary circuits always disconnected before the secondary circuits are worked on) shall be provided with a means for short-circuiting them which can be readily connected while the primary is energized, and which are so arranged as to permit the removal of any instrument or other device in such circuits without opening the circuits.

(*b*) Secondaries, where fed from primaries above 2,400 volts, unless otherwise adequately protected from injury and contact of persons, shall be in permanently grounded conduit.

Order 715.—**Grounding Low Voltage Circuits of Instrument Transformers.**

(*a*) The low voltage circuits of instrument transformers shall be permanently grounded unless the circuits are installed, guarded and plainly identified as required for the high-voltage circuits of the transformers.

This will sometimes require marking to distinguish such a low-voltage circuit from others with which it is associated, but which are protected by ground connections.

Order 716.—**Grounding Transformer Cases.**

(*a*) The metal case or exposed frame of each transformer and reactance and similar equipment, which is located where dampness or inflammable gas normally exists, or which is connected to a circuit operating at over 150 volts to ground, shall be permanently grounded.

Exception is permissible where the entire transformer is isolated or guarded as required for the highest voltage circuit connected with the transformer, and is plainly and conspicuously identified as of that voltage.

Order 717.—**Installing Transformers.**

(*a*) When transformers must be installed on customers' premises, they may be installed—

1. On poles, in which case they must comply with the following:

Transformers, regulators and lightning arresters, when located below conductor or other attachments and less than five (5) inches from pole surface, shall be maintained on that side of the pole opposite to the climbing side, at that point.

On buckarm poles only the climbing space itself need be kept clear. The installation of transformers on buckarm poles should be discouraged.

When the conductors are to be worked upon alive, live parts of switches, automatic cutouts, and lightning arresters, if exceeding 300 volts to ground, when on the climbing side of the pole, shall be inclosed or suitably guarded, if less than twenty (20) inches from the pole center, except when located on or above the top crossarm.

2. In transformer vaults, in which case they must be isolated and made inaccessible to unauthorized persons.
3. In buildings in which other equipment is installed, in which case the construction employed must comply with these Orders, as they may apply.

LIGHTNING ARRESTERS.

Order 718.—**Provisions for Disconnecting.**

(*a*) Lightning arresters on lighting and power circuits shall be so installed that they may be readily disconnected from conductors to which they are connected by air-break manual disconnectors, having air gaps of not less than four times the equivalent needle point sparking distance of the voltage for which the arresters are set, and never less than eight (8) inches.

Order 719.—**Location.**

(*a*) Lightning arresters when installed inside of buildings shall be located as far as possible from all other equipment and from combustible parts of the building.

(*b*) Lightning arresters when installed for the protection of utilization equipment may be installed on supply lines or equipment either within or without buildings or inclosures containing equipment to be protected.

Order 720.—**Ground Wires.**

(*a*) Ground wires of lightning arresters shall be run as directly as possible and be of low impedance and ample carrying capacity.

Order 721.—**Grounding Frames.**

(*a*) All noncurrent-carrying metal parts of lightning arresters shall be grounded unless effectively isolated by elevation, or guarded as required for live parts of the voltage of the circuit to which the arrester is connected, and suitably identified as of that voltage.

Order 722.—**Guarding Live Parts.**

(*a*) All current-carrying parts of lightning arresters on circuits above 750 volts, unless effectively isolated by elevation, shall be adequately guarded to protect persons from inadvertent contact with them, or from injury by arcing.

CONDUCTORS.

Order 723.—**Electrical Protection.**

(*a*) Conductors shall be suitable for the location, use, and voltage, and (except grounded conductors, ground wires and conductors of circuits the interruption of which may cause special hazard) shall be protected against excessive current by the design of the system, or by suitable automatic cutouts.

(*b*) Neutral conductors in three-wire systems shall be arranged without automatic cutouts interrupting their continuity, and without switches unless the switch opens all conductors of the circuit with one operation. In two-wire branches from three-wire circuits the conductor connected to the neutral is not considered a neutral conductor.

(*c*) All conductors grounded for the protection of persons shall be arranged without automatic cutouts interrupting their continuity between the source of electrical supply and the point to which the ground wire is attached. Switches shall either open all conductors of the circuit with one operation, or be placed only on ungrounded conductors of the circuit.

Where the utilization equipment is connected to electrical supply lines, the point of connection is considered as the source of electrical supply.

Order 724.—**Mechanical and Thermal Protection.**

(*a*) Where exposed to mechanical injury, suitable casing, armor, or other means shall be employed to prevent injury or disturbance to conductors, their insulation or supports. Conductors used as meter loops shall be substantially supported or shall be in approved conduit or substantial noncombustible, nonabsorptive casings.

(*b*) Where conductors with insulating coverings are closely grouped (as on the rear of switchboards or in cable ways, etc.), each conductor shall have a substantial noncombustible outer covering.

(*c*) Ungrounded bare conductors shall be used only for switchboard, panelboard, and storage battery, electrolytic, low-voltage furnace, welding circuit and similar connections, and for trolley wires and other contact conductors. (See Order 705.)

Order 725.—**Isolating or Guarding.**

(*a*) All fixed conductors having insulated coverings and operating at over 300 volts to ground, and bare ungrounded conductors at all voltages shall (unless guarded as required in Order 726) be so isolated by elevation [as required by Order 704 (*a*)] that no person can inadvertently come in contact with them.

(*b*) When the voltage of an overhead supply circuit entering a building exceeds 750, a "sectionalizing" or pole top switch shall be installed outside of the building to effectively open the circuit, or in lieu thereof an oil switch with disconnectors may be installed within the building at a point as near as possible to the entrance of the supply circuit. These switches shall be arranged so as to be locked in an open position.

Order 726.—**Guarding Conductors Over 300 Volts.**

(*a*) For inclosing insulated conductors, approved permanently grounded metal conduit, waterproof insulating conduit, or grounded metal sheathing shall be used, except that in dry places, ducts, runways, or compartments of suitable fire-resistive material may be used for conductors below 750 volts, if containing no exposed combustible material. In damp places conduit shall be made waterproof and provided with suitable means for draining off condensation, unless the conductors contained are lead-sheathed cable.

(*b*) Where open insulated conductors between 300 volts to ground and 750 volts, or open bare ungrounded conductors at any voltage below 750 volts (excepting bare wires used for heating at voltages not exceeding 300 volts and not exceeding 250 volts to ground) are necessarily brought closer to the floor line than eight (8) feet, they shall be guarded by permanent screens or inclosure.

(*c*) Where persons at any time remove or pass by screens or other guards while conductors are alive, such screens or guards shall be of insulating material or so arranged that they can not be brought into contact with the live parts, and all conducting floors, walls, machine frames, and similar surfaces within eight (8) feet below the conductors or three (3) feet horizontally from them, shall be covered with suitable insulating platforms, mats or covers. (See Order 705 (*d*).)

Dependence should not be placed on the unprotected insulating covering as a suitable inclosure for such conductors near the floor line. Other guards should be provided to protect the insulation and to secure the safety of persons who must come near the conductors.

Order 727.—**Guarding in Damp or Hazardous Locations.**

(*a*) Conductors in damp locations or where exposed to corrosion, if not in waterproofed conduit, or in waterproof metal sheaths in other suitable ducts, shall be effectively isolated and supported on insulators of a suitable type.

(*b*) Conductors in locations where inflammable gas or flyings normally exist shall be in metal conduit or metal-sheathed cable. All fittings and outlets of such conduit and cable shall be electrically and mechanically continuous with the conduit or metal sheath, and the conduit and cable shall be sealed to prevent the entrance of gases by the use of suitable potheads or equivalent devices.

Order 728.—**Precaution to Avoid Excessive Inductance and Eddy Currents.**

(*a*) Supply conductors of a.c. or d.c. circuits shall not be run in separate iron conduits or on opposite sides of

I beams or other iron structures or otherwise run so as to increase abnormally the self-inductance of the circuit.

Such construction introducing large self-inductance in d.c. circuits causes fuses to blow explosively; in a.c. circuits it causes heating due to eddy currents in the metal.

Order 729.—**Pendants and Portables.**

(*a*) Pendant or portable conductors shall not be installed or used on circuits operating at over 150 volts to ground, unless they are of type suitable for the voltage and conditions, and conform to the requirements of Orders Nos. 761, 762, 763 and 764.

Order 730.—**Temporary Wiring.**

(*a*) Temporary wiring and equipment which is not in compliance with these Orders, may be used, but only when under competent supervision, or protected by suitable barriers or warning signs while it or neighboring wiring is alive and accessible to any person.

Order 731.—**Taping Ends and Joints.**

(*a*) Ends and joints of insulated conductors, unless otherwise adequately guarded, shall have equal insulating covering with other portions of the conductor.

Order 732.—**Grounding Service Conductors and Conduits.**

(*a*) Metal conduit or sheathing encasing service conductors from either overhead or underground lines shall be permanently grounded.

(*b*) Metal conduit or sheathing encasing either overhead or underground service conductors shall be directly and permanently grounded to a water pipe or other good ground. The ground wire of service conduit and sheathing shall be independent of all other grounds and shall have a conductance of not less than that of No. 6 B. & S. G. copper.

SWITCHES, FUSES AND OTHER CUTOUTS, CONTROL AND OTHER SIMILAR DEVICES.

Order 733.—**Accessible and Indicating.**

(*a*) All switches, automatic cutouts, controllers, starting rheostats, autostarters and other control devices shall be readily and safely accessible to authorized persons; they shall be so located or marked when controlling circuits of over 1,320 watts, as sufficiently to indicate their function and the location and character of the equipment controlled by them and whether they are open or closed, except cutouts and switches in sealed inclosures. They shall be so installed as to minimize the danger of accidental operation and, where practicable, so that gravity can not close them; and such switches as close by gravity shall be provided with a proper latch to prevent accidental closing.

Order 734.—**Hazardous Locations.**

(*a*) When necessary to install switches or other control devices in locations where explosives, inflammable gas or inflammable flyings exist, they shall be suitably protected. (See Order 706.)

Order 735.—**Where Switches Are Required.**

(*a*) Suitable switches shall be inserted in all feed wires connecting utilization installations to either overhead or underground lines, and such switches shall be placed in the nearest readily accessible place at the point where the wires enter the building and arranged to cut off the entire current.

(*b*) Suitable switches shall be inserted in all circuit leads (except a ground conductor) to motors, transformers, storage batteries, electric furnaces, ranges, ovens and similar utilization equipment, except parts of apparatus intended to operate as a unit.

Switches installed for use on lighting and similar circuits under 1,320 watts need not conform with the preceding paragraph.

Order 736.—**Character of Switches to Use.**

(*a*) Switches shall have a rated capacity safely to interrupt, at the working voltage, the greatest current which they will be required to carry continuously. Rating means that they shall operate safely at 50 per cent overload in amperes and at rated voltage under the most severe conditions which they are liable to meet in practice.

(*b*) Disconnectors are not rated as capable of opening safely under load and shall be accessible only to properly qualified persons, and shall be provided with signs against opening them while carrying current.

Interlocking arrangements are desirable to prevent opening of such switches under load.

(*c*) Means shall be provided so that switches controlling motors, storage batteries, transformers, electric furnaces, and similar utilization equipment can, when closing would cause a hazard, be locked in the open position and tagged to prevent careless closing while work is being done on the equipment controlled by them.

Small capacity snap switches, if near machines and in plain sight from all parts of the machines controlled, are exempted.

(*d*) Knife switches shall maintain such alignment under service conditions that they may be closed with a single unhesitating motion into their contacts.

Order 737.—**Disconnection of Fusible Cutouts Before Handling.**

(*a*) Fusible cutouts in circuits operating at over 150 volts to ground shall be so arranged that their ungrounded current-carrying parts can not be touched by persons re-fusing the cutouts until the fuses have been disconnected from all sources of electrical energy, or in lieu thereof, fuses shall be inclosed in a metal or insulating box on the outside of the cover of which shall be legibly marked a warning against removal of fuses before the switch controlling same is opened.

Where fusible cutouts in circuits above 150 volts to ground are in locked cabinets or otherwise made inaccessible to all but qualified persons, sufficient protection is usually secured by the use of a switch accessible only to such persons—this switch to be placed or arranged so that fuses may be disconnected from all sources of electrical energy.

Order 738.—**Arcing of Suddenly-Moving Parts.**

(*a*) Fuses and circuit breakers shall, as far as possible, be so located and shielded that persons will not be burned by their operation.

(*b*) Parts, such as handles or levers of circuit breakers, which may move suddenly in such a way that persons in the vicinity are liable to be injured by being struck by them, shall be guarded or isolated, where practicable.

Order 739.—**Grounding Noncurrent-Carrying Metal Parts.**

(*a*) Exposed noncurrent-carrying metal parts of switch and fuse cases, levers, and other similar parts to which leakage may occur from live parts, shall be permanently grounded according to the provisions of Order 703.

Order 740.—**Guarding Live Parts of Switches and Automatic Cutouts.**

(*a*) All manual switches shall have suitable casings or guards protecting the operator from danger of contact with current-carrying parts, effective during ordinary operation, excepting switches on circuits not exceeding 150 volts to ground which are not located in permanently damp places or where local conditions entail a particular hazard.

SWITCHBOARDS.

Order 741.—**Accessibility and Convenient Attendance.**

(*a*) Switchboards and panels containing exposed live parts above 150 volts to ground shall be so isolated or guarded as to be inaccessible to unqualified persons.

(*b*) Instruments, relays or other devices requiring reading or adjustment shall be so placed that work can be readily performed from the working space.

Order 742.—**Location and Illumination.**

(*a*) Switchboards shall, where practicable, be so placed that the persons necessarily near the board will not be endangered by machinery or equipment located near the board.

(*b*) Means for adequate illumination shall be provided.

Order 743.—**Arrangement and Identification.**

(*a*) Connections, wiring and equipment of switchboards shall be arranged in an orderly manner and all switches and cutouts shall be plainly marked, labeled or arranged so as to afford ready means for identifying circuits or equipments supplied through them.

(*b*) Switchboards shall have live parts which are ordinarily isolated or guarded, but which may occasionally require adjustment or repair during operation, so arranged that suitable portable covers or shields can be effectively placed to protect workmen from contact with any neighboring live parts.

It is recommended that a diagram of switchboard connections and devices be kept posted in some convenient place near such equipment.

Order 744.—**Spacings and Barriers Against Short Circuit.**

(*a*) Bare parts of different potential on any switchboard or panel shall be as few as practicable and these parts shall be effectively separated.

(*b*) Bare parts, including bus bars, shall, when practicable, be so located or provided with barriers or substantial insulating coverings that parts of different potential can not be accidentally short-circuited, by tools or other conducting objects.

EXCEPTION: This does not apply to panel boards mounted in suitable cabinets.

Order 745.—**Grounding Frames.**

(*a*) Switchboard frames shall be permanently grounded, under the conditions and with the exceptions noted in Order 703.

Order 746.—**Guarding Live Parts.**

(*a*) All switchboards and panel boards having exposed current-carrying parts operating at over 150 volts to ground, and not isolated by elevation, shall be suitably inclosed in cabinets, screens, or rooms or other inclosures to make them inaccessible to others than the authorized operator.

(*b*) Conducting floors shall be provided with a suitable insulating platform or mat so placed that no person can inadvertently touch live parts unless standing on the insulating platform or mat.

(*c*) Theatre switchboards at any voltage shall be elevated or guarded by suitable railings, to prevent contact with live parts by passers-by. (See Orders 705 and 740 (*a*).)

(*d*) Plug type switchboards on constant current systems and all such boards operating at more than 150 volts to ground shall have no current-carrying parts exposed on face of boards. Plug connectors shall have all current-carrying parts guarded while they are alive.

MOTORS AND MOTOR-DRIVEN MACHINERY.

Order 747.—**Control Devices.**

(*a*) Separately excited d.c. motors, motor generators and converters larger than 10 kilowatt, where it is possible for them to be driven at excessive speed from the d.c. end, shall be provided with speed limiting devices.

(*b*) Where the speed control of d.c. motors is accomplished by varying the field resistance, and where the range of the field rheostat is sufficiently great to make a dangerous speed obtainable, and where no speed limit devices are used, the field rheostats shall be arranged with no-voltage release or other devices, so that the motor can not be started under dangerously weakened field.

Motors which are designed to permit starting safely under weakened field, are not included in the above.

Care should be exercised, and no-voltage or other devices provided if necessary to prevent a d.c. motor from being started with resistance in series with the field, if such resistance would not permit a safe field excitation.

(*c*) Where speed-limiting and stopping devices are electrically operated, the control circuits by which such devices are actuated shall be adequately guarded by conduit or otherwise against mechanical injury.

(*d*) Manually-controlled starters for motors shall be so designed and circuits so arranged that they return automatically to the "off" or starting position upon failure of the energy supply, except where motors are under competent supervision and equivalent protection is otherwise provided.

Order 748.—**Hazardous Locations.**

(*a*) Motors in which sparking can occur during operation shall, where practicable, be kept out of locations where explosives or inflammable gas or inflammable flyings exist. Where necessarily located in such places, they shall be suitably protected. (See Order 706.)

Order 749.—**Deteriorating Agencies.**

(*a*) Where failure of equipment would be hazardous to life, suitable guards or inclosures shall be provided to protect the current-carrying parts, insulation and leads of motors where installed directly under equipment or in other locations, where dripping oil, excessive moisture, steam, vapor, chemicals or other similar injurious agents exist. The frames and other noncurrent-carrying parts of equipment in those locations shall be permanently grounded. (See Order 703 (*c*).)

Order 750.—**Guards for Live Parts.**

(*a*) The live parts of motors operating at over 250 volts, unless such live parts are inclosed or isolated by elevation at least eight (8) feet above the floor line, shall, if practical, be provided with permanent inclosures, or other suitable guards; such inclosures so arranged as to prevent persons or conducting objects from inadvertently coming or being brought into contact with said live parts.

(*b*) Suitable insulating mats or platforms of substantial construction and providing good footing shall be so placed on floors, and, if necessary, on frames of machines having exposed live parts above 150 volts to ground, that operators can not touch such parts unless standing on the mats or platforms.

1. The suitable guarding of live parts by inclosures or barriers effective during attendance or necessary handling of live parts will obviate the necessity for insulating mats, and where such mats are

impracticable from the nature of the location or processes carried on; guards shall always be used.

2. Where connections are used in motor leads, these shall be provided with insulating covering equal to that on the conductors.
3. Where necessary, steps and handrails shall be installed on or about large machines, to afford safe access to live parts, which may be examined or adjusted during operation.

(*c*) Where two or more machines operating at over 150 volts to ground are mechanically coupled together, and the operator can touch the frames of more than one at a time, the frames of all such machines shall be grounded, unless they are bonded together electrically and, if operating at above 300 volts to ground, surrounded by insulating mats or platforms.

Order 751.—**Guards for Moving Parts.**

(*a*) Suitable guards or inclosures shall be arranged at each motor when necessary to prevent persons or objects from inadvertently coming in harmful contact with moving parts.

ARC WELDERS AND ELECTRIC FURNACES.

Order 752.—**Arc Furnaces.**

(*a*) Electric furnaces, such as those used for arc welding, where intensely glowing or incandescent arcing parts are exposed, shall be inclosed, so that those parts will not be accessible or visible to unauthorized persons. Suitable protecting screens, hoods, gloves, and other devices shall be provided for the authorized operators or others who must work or come near such parts.

Order 753.—**Grounding.**

(*a*) The outside noncurrent-carrying metallic frames of furnaces which contain live parts connected to circuits above 150 volts shall be grounded.

(*b*) Where the heating element is a low voltage secondary or part of a low voltage circuit, it shall be permanently grounded if the operator must bring tools or conducting materials in contact with the element.

Order 754.—**Guarding Live Parts.**

(*a*) Except at points where necessarily left exposed, all current-carrying parts (including those of auxiliary control equipment) shall be suitably guarded in permanently grounded metal inclosures or substantial insulating material. All parts connected directly, or through the inductive relations of transformer windings to circuits above 150 volts, shall, if practicable, be so guarded.

LIGHTING FIXTURES AND SIGNS.

Order 755.—**Grounding and Guarding.**

All lighting fixtures and other similar electrical devices shall be adequately protected. This will involve:

(*a*) Grounding of noncurrent-carrying metal parts when in locations where explosives, inflammable gas, or inflammable flyings normally exist in dangerous quantities.

(*b*) When within eight (8) feet from metal, concrete or permanently damp floors or stairways, including fire escapes, galleries or bridges as in machine shops, stables, laundries, etc., or when within five (5) feet from conducting surfaces, such as metal piping, metal radiators, stoves, furnaces, plumbing fixtures, damp walls, or similar conducting surfaces, as in kitchens, machine shops, print shops, etc., either:

1. Grounding noncurrent-carrying metal parts; or
2. Equipping fixtures, brackets or lights with keyless sockets controlled from wall switches; or
3. Equipping fixtures, brackets, or lights with porcelain key sockets, insulated pull chain porcelain sockets, or other approved sockets of insulating material.

Equipment and fixtures in series circuits, including those in series on railway circuits, need not be grounded under this Order, but should be guarded, in so far as is practicable, from approach. On grounded systems it is recommended that the center contact of socket and receptacles be connected to the ungrounded side, to reduce the liability of breakdown of the dielectric between the inner screw shell and the outer grounded brass shell.

Order 756.—**Accessibility and Guarding of Signs.**

(*a*) Electric signs elevated more than thirty (30) feet above roadways or footways, etc., or where signs are erected over roofs or projections of buildings where the vertical distance from the roofs or projection to the top of the sign is greater than the horizontal distance from the edge of the roof to the sign shall, where attendance is required while the sign is in position, be provided with substantial, safely accessible runways, ladders or platforms.

(*b*) Electric signs outside buildings shall have no ungrounded current-carrying parts normally exposed to contact of workmen on or in the building. Receptacles of lamps shall be extended so that the screw base of the lamp or plug can not be exposed when alive.

Order 757.—**Control of Outdoor Signs.**

(*a*) All electric signs shall be provided with switches and fuses so arranged as to entirely disconnect all feed wires of the sign.

It is recommended that before any work is done on sign wiring, the switch shall be opened and the fuses removed.

Order 758.—**Connectors for Signs.**

(*a*) Electric signs shall be so arranged that changeable connections can be made manually only by approved connectors in which all poles of the circuit are simultaneously interrupted. All live current-carrying parts of pin and socket connectors shall be provided with approved guards, so as not to be exposed.

Order 759.—**Isolating or Guarding Lamps in Series Circuits.**

(*a*) Arc lamps and other devices in series circuits, except grounded circuits of which no part exceeds 150 volts to ground, shall be effectively isolated or suitably guarded.

Isolation will ordinarily be deemed sufficient when a vertical clearance is provided from floors or other ordinarily accessible places within buildings of eight (8) feet, from footways outside buildings of ten (10) feet, and from roadways, of fifteen (15) feet. Horizontal clearance from windows, porches and other spaces accessible to the general public should not be less than three (3) feet. The above Order shall not apply to street lighting standards fed from underground circuits, provided the height of the lamp be not less than eight (8) feet from the ground.

(*b*) Lamps shall be secured from falling on persons or traffic passing below, and the hanger, rope, chain or other means adopted for holding the lamps shall be regularly and systematically inspected. Metal chains used for lowering lamps in series circuits shall be interrupted by a suitable strain insulator the minimum height of which from the floor or ground shall be eight (8) feet, whether lamp is in position or lowered.

It is recommended that no workman be allowed to work on any device in a series circuit when said circuit is alive.

Order 760.—**Safe Access to Arc Lamps.**

(*a*) A suitable device shall be provided by which each arc lamp or other device on series circuits may be safely and entirely disconnected from the circuit before it is handled, unless always worked on from suitable insulating stools, platform or tower wagons, and treated as under full voltage of the circuit concerned. (See note under Order 759 (*b*).)

PORTABLE DEVICES, CABLES AND CONNECTORS.

(Not including those for Signal Systems.)

Order 761.—**Insulation and Grounding.**

(*a*) Portable devices shall be provided with an adequate dielectric interposed between ungrounded current-carrying parts and those external surfaces which persons can touch.

Toasters, grills or other heating devices in which the current-carrying parts at high temperature are necessarily exposed, are exempted.

In locations where the dielectric is exposed to mechanical injury, it shall be suitably protected.

The grounding of frames of portable devices, especially in connection with voltage above 150 and for any voltage when used in locations such as bathrooms where persons may easily touch other good conductors at the same time as the device, is recommended as a safety measure where practicable, and if suitable means are available, but can not be reasonably required unless such means are available. Such grounding may be obtained by the use of a three-wire conductor to portables, one wire being used for the ground wire and the connectors being properly designed so that wrong connections can not be made.

Order 762.—**Cable Connectors.**

(*a*) Where used with portable conductors, connectors must disconnect all poles from the live source of energy.

(*b*) Connectors shall be so constructed with guards that the person using them can not inadvertently in contact with live parts or be burned by arcing from the largest current for which they are approved.

(*c*) In locations where one end of a separable connector is left alive, or where the two ends of a separable connector are both connected to live circuits (as in battery charging), the ends in question shall have live parts suitably guarded.

(*d*) Where attached to portable cables, suitable means shall be provided for relieving the terminal connections of cable from strains.

Order 763.—**Identification of Conductors and Connectors.**

(*a*) Where used with portable devices, the cases of which are designed to be grounded, the portable cable and the separable connectors (both to the device and the circuit) shall, where practicable, be provided with identified parts so that the ground wire in both the fixed wiring and portable cable will always be attached to the proper terminals of the connectors. Separable connectors shall be so constructed that wrong connection between the two parts is impossible.

Order 764.—**Use of Portables and Pendants.**

(*a*) Portable and pendant conductors shall be of a type suited to the voltage and conditions under which they are used.

In car houses and similar locations where service at low voltage is not available and where necessary to use low voltage devices in series with lamps on trolley circuits, the devices should be used only with great caution and preferably placed on the grounded side of the circuits.

(*b*) Where portable conductors are required, fixed sockets or connectors shall be provided at safely accessible points, and so located that liability of such conductors being brought into dangerous proximity with other live parts will be reduced as far as practicable.

(*c*) Where exposed to dampness or corrosive influences, portable conductors shall be of a type specially suited; and where exposed to inflammable gas or flyings they shall be so protected or isolated by elevation that they can not be readily damaged. In the latter case connectors shall be so arranged as not to be exposed to accidental opening by persons handling the portable conductors or devices.

(*d*) Portable and pendant conductors shall be so installed that no strain is placed on the terminal connections and shall have no joints except at suitable fittings.

The use of worn or defective portable and pendant conductors should be avoided because of the danger to users by wire strands piercing the insulating covering, or becoming exposed through abrasion of the covering.

ELECTRICALLY OPERATED CARS, CRANES AND ELEVATORS.

Order 765.—**Guarding Live and Moving Parts.**

(*a*) All current-carrying parts connected to circuits above 150 volts shall be so isolated or guarded that no person can inadvertently come in contact with them. (See Order 705 (*c*) for trolley wires.)

(*b*) All conductors in locations accessible to the public shall be run in conduit, armored cable, or molding, the exposed metallic parts of which shall be permanently grounded.

(*c*) Guards for the current-carrying parts of unisolated electrical equipment, such as controllers, motors, transformers, automatic cutouts, circuit breakers, switches and other devices, shall consist of casings or shields of permanently grounded metal or of substantial insulating material.

(*d*) All parts of electrical equipment shall be so isolated or guarded that the liability of persons being struck or burned by sparking, flashing or movement during operation is reduced as far as practicable.

Order 766.—**Grounding Noncurrent-Carrying Parts.**

(*a*) All exposed noncurrent-carrying metal parts of electrical equipment at over 150 volts to ground shall be permanently grounded.

(*b*) The metallic parts of cranes, derricks, hoists and similar equipment (either fixed or traveling on rails) on which wire cables and chains are maintained, shall be effectively grounded when operated in the vicinity of supply lines, whether the cranes or similar equipment are themselves electrically operated or not.

The ground connection through well bonded track rails will be considered satisfactory for cars and cranes.

Order 767.—**Control of Energy Supply to Cars and Cranes.**

(*a*) Readily accessible means shall be provided whereby all conductors and equipment located in or on cars or cranes, can be disconnected entirely from the source of energy at a point as near as possible to the trolley or other current collectors. A circuit breaker or switch capable of interrupting the circuit under heavy loads shall be used, unless the current collector can be safely removed under heavy loads, from the trolley or third rail.

Order 768.—**Control of Movement.**

(*a*) Means shall be provided whereby the operator (whether motorman or elevator attendant) can prevent the starting of the equipment by unauthorized persons while he is absent from his post.

Removable reverse levers or controller handles and locked doors to the operator's cab, are among the most effective means.

(*b*) The car control lever of passenger elevators shall be located so that the operator can readily face the principal car opening.

(*c*) Provision shall be made in all a.c. elevator circuits to guard against changing direction of elevator due to the unintentional reversal of any phase of the circuit.

TELEPHONE APPARATUS AND SIGNALING DEVICES.

Order 769.—**Guarding and Grounding.**

(*a*) Where telephone apparatus which must be handled by persons is permanently connected to overhead signal circuits exposed by supply lines over 400 volts to ground, provision shall be made by one of the following methods against shock to persons handling apparatus:

1. The use of suitable protective devices, including fuses and arresters.
2. The grounding of all exposed noncurrent-carrying metal parts and the suitable guarding of all ungrounded current-carrying parts.
3. The arrangement of apparatus in such a way that persons using it will be obliged to stand on a suitably insulated platform, in a suitably insulated booth, or on other effective insulating surface.

(*b*) Such signaling devices as fire and police alarm boxes, and telegraph test boxes, shall have the accessible noncurrent-carrying metal parts permanently grounded, wherever the character of service gives valid objection to the use of arresters or transformers on the signal circuit.

Police alarm boxes should usually be protected by arresters operating at 400 volts to ground, placed in the connecting leads outside the box.

(*c*) Fire alarm boxes, if not protected, shall be provided with suitable insulating material between the exposed frame and operating hook and the circuit within, this insulation to be capable of withstanding, if practicable, the highest voltage of the supply circuits to which the fire alarm circuit is exposed.

Order 770.—**Grounding of Arresters for Signaling Systems.**

(*a*) Arresters for signaling systems shall be permanently and effectively grounded.

(*b*) Metal cases of outdoor apparatus for signal systems shall be grounded in accordance with Order 703.

MISCELLANEOUS.

Order 771.—**Vehicle and Subway Illumination.**

(*a*) All passenger cars in subways or other locations where artificial illumination is indispensable shall be equipped with an auxiliary system of emergency lighting.

This should, where practicable, be arranged so as to become effective when the regular source of illumination fails.

(*b*) In subways in which passenger cars are operated where the power for propulsion is from a separate source than that of subway illumination, reliance upon the illumination of the tunnel will be sufficient.

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